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Journal of the Society of Arts.

FRIDAY, FEBRUARY 4, 1859.

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EXAMINATIONS, 1859.—NOTICE TO CANDIDATES.

In reference to the five subjects referred to in the note to Par. 22 of the Examination Programme for this year, which states that no papers will be set in Navigation and Nautical Astronomy, in Astronomy, in Botany, in Agriculture, or in Political and Social Economy, unless returns are received before the 1st of February, that ten candidates are preparing themselves in these subjects for the Previous Examination, the Council hereby give notice that papers will be set in Botany and in Political and Social Economy, but that no papers will be set in Navigation and Nautical Astronomy, in Astronomy, or in Agriculture.

EXAMINATIONS, 1859.—LOCAL BOARDS.

The following Local Boards have been appointed since the last announcement:—

For Chelmsford.

Mr. Edward Copland, Chelmsford.
Mr. Horatio Piggot, solicitor, Chelmsford.
Mr. Daniel Wheeler, surgeon, Chelmsford.
Rev. George Wilkinson, Chelmsford.
Mr. William Cutts, Chelmsford, *Secretary.*

For Halifax.

Rev. J. H. Gooch, Heath Grammar School, Halifax, *Chairman.*
Mr. A. Baldwin, Barum-top, Halifax.
Mr. S. Baldwin, Milton-street, Halifax.
Mr. T. Barraclough, Trinity-place, Halifax.
Mr. J. Barrowby, Booth-town, Halifax.
Rev. R. L. Carpenter, B.A., Milton-place, Halifax.
Mr. L. Child, the Shed, Haley-hill, Halifax.
Mr. Thomas Cordingley, Ringby, near Halifax.
Dr. Garlick, F.R.C.S., Lord-street, Halifax.
Mr. G. Gibb, 6, Corporation-street, Halifax.
Mr. S. Hartley, Bowling Dyke Mill, Halifax.
Mr. J. D. Hutchinson, Hampden-place, Halifax.
Mr. Joseph Jennings, Black-wall, Halifax.
Mr. Thos. Midgley, Bowling Dyke Mill, Halifax.
Mr. B. Musgrave, 5, Greenhill-terrace, Halifax.
Mr. E. Taylor, Horton-street, Halifax.
Mr. G. Whitely, B.A., Fergusson-street, Halifax.
Mr. A. C. Forster, solicitor, Halifax, *Secretary.*

For King's Lynn.

The Mayor of Lynn.
Mr. W. Cooper, High-street, Lynn.
Mr. R. Cruso, New Conduit-street, Lynn.
Rev. F. L. Currie, Clenchwarton, near Lynn.
Mr. Henry Edwards, Goodwin's-fields, Lynn.
Mr. W. Everard, King-street, Lynn.
Mr. F. Kendle, Nelson street, Lynn.
Mr. Joseph Kerkham, High-street, Lynn.
Mr. Walter Moyse, King-street, Lynn.
Mr. James Nurse, King-street, Lynn.
Mr. F. R. Partridge, Littleport-street, Lynn.
Mr. Lionel Self, Nelson-street, Lynn.
Mr. W. Taylor, High-street, Lynn.
Mr. Henry Wells, High-street, Lynn.
Mr. J. G. Wigg, Saturday Market, Lynn.
Rev. Canon Wodehouse, St. Ann's-street, Lynn.

[The above gentlemen form the Council of the Athenæum.]

Rev. E. F. E. Hankinson, St. John's-place, Lynn.
Rev. W. Leeper, Goodwin's-fields, Lynn.
Dr. Lowe, King Staith-square, Lynn.
Mr. Lupton, New Conduit-street, Lynn.
Rev. E. Price, London-road, Lynn.
Mr. J. T. Wigner, London-road, Lynn.
Rev. T. White, Master of the Grammar School, Lynn.
Mr. T. Burton, 23, South Everard-street, Lynn, *Secretary.*

For Macclesfield.

Mr. T. U. Brocklehurst, The Fence, Macclesfield, *Chairman.*
Mr. James Birch, Park-lane, Macclesfield.
Mr. E. Chadwick, Hibel-road, Macclesfield.
Mr. R. Higson, Crompton-road, Macclesfield.
Mr. Wm. Partington, James-street, Macclesfield.
Mr. S. Rushton, Macclesfield.
Mr. W. Smale, Park-lane, Macclesfield.
Mr. Thomas Smith, Brook-street, Macclesfield.
Mr. Wm. Taylor, High-street, Macclesfield.
Mr. C. Thompson, Oxford-road, Macclesfield.
Mr. D. B. Curwen, Park-grange, Macclesfield, *Secretary.*

For Newcastle-on-Tyne.

Rev. W. R. Burnett.
Rev. James Henderson.
Rev. C. W. N. Hyne.
Rev. James Snape, Royal Grammar School.
Mr. Joseph Forster, Church of England Institute, *Secretary.*

For Northowram.

Rev. S. R. Eddy, B.A., Coley, near Halifax.
Mr. J. O. Greenwood, Quarry House, Northowram.
Mr. W. H. Lord, Spring House, Shelf.
Mr. W. Moore, Northowram Hall.
Mr. J. W. Wood, Mountain, Shelf, near Halifax, *Secretary.*

For Pembroke Dock.

Mr. Robert Saunders.
Mr. J. Walker.
Mr. F. Allan, *Secretary.*

For Sheerness.

Mr. R. Crockford, Beach-street, Sheerness.
Mr. W. Henwood, Exeter House, Mile Town, Sheerness.
Mr. J. Road, 7, Edward-street, Banks Town, Sheerness.
Mr. W. B. Robinson, Navy-terrace, Sheerness.
Mr. S. Willcocks, Chapel-street, Mile Town, Sheerness.
Mr. H. Morgan, 36, James-street, Marine Town, Sheerness, *Secretary.*

NINTH ORDINARY MEETING.

Wednesday, Feb. 2, 1859.

The Ninth Ordinary Meeting of the One Hundred and Fifth Session was held on Wednesday, the 2nd inst., Thomas Graham, Esq., F.R.S., Master of the Mint, in the chair.

The following candidates were balloted for and duly elected members of the Society :—

Bower, John Abigal
Dilke, Ashton W.
Dodge, N. S.
Gouldsmith, George
Haywood, Thomas Burt
Henry, Michael
Lamb, Lieut. Henry
Neil, Edward Bernard
Sargenson, W. Sugden
Smith, Henry
Smith, Wm. Ackers
Somes, Joseph
Tress, Richard

As an Honorary Corresponding Member.
Romberg, Edward.

The following Institution has been taken into Union since the last announcement :—

Wolverhampton, Working Men's College.

The Paper read was—

ON ALUMINIUM.

By P. Le Neve Foster, M.A., Secretary of the Society of Arts.

The ancients held that all material substances could be resolved into four undecomposable bodies, viz., air, earth, fire, and water ; our modern chemists have not only shown that these are no elements at all, but that there are upwards of fifty substances which science at the present day recognises as incapable of being decomposed. Air is shown to be composed of two elementary bodies, oxygen and nitrogen; water, of hydrogen and oxygen. Fire is no substance at all ; rather one the of phenomena which heat exhibits; and in what category heat itself is to be placed, is a matter about which the learned are not agreed. As for earth, the fourth element of the ancients, we all know that this consists of a variety of earths, each of which, by the later discoveries of the chemist, has been shown to be the oxide of a metal. The main constituent of one of these earths is alumina, the oxide of the metal aluminium. Aluminium, in one form or another, is distributed in the utmost profusion throughout the whole composition of our globe, so far, at least, as the crust of the earth is concerned. There is probably no other metal which is so abundant, or which plays a more important part in the world's economy; not, indeed, in its metallic form, but in combination with other substances. In combination with oxygen and silicium it forms the essential portion of our granite rocks, which geologists look upon as the very foundation of our soil. Feldspar, one of the main characteristic constituents of granite, is a double silicate of alumina and potash. It is present in our slates and in schist; but, above all, in all those immense beds of various descriptions of clay, which play so important a part in agriculture and in the arts. It is scarcely possible to conceive any more important influence than that which the compounds of aluminium exert in relation to our daily wants and comforts. The silicate of alumina is essential to the composition of the clays ; take this away and you have no longer clay. Without clay what would become of the fertility of our fields, its impermeable beds retaining the water which soaks down to them, forming wells and reservoirs for water. Without clay, where would be our pottery, bricks, materials for the furnaces of our factories, hydraulic cements for our docks and canals? Without alumina what would become of our dye works? for it is this all-important substance which enables us to fix the rich and varied colours on our silks, our wools, and our cottons. In the preparation of skins it also is largely used.

Aluminium forms an essential portion of a large number of our most brilliant gems. The corundum, which almost rivals the diamond, is pure alumina; coloured blue it becomes the sapphire ; red it takes the name of the Oriental ruby, and yellow it is known as the Oriental topaz. The Oriental amethyst and Oriental emerald are varieties of the corundum. Emery, too, is a coarse variety of the corundum.

But, however abundant these earths, and however largely diffused over the face of our globe these ores of aluminium may be, it must not be imagined that aluminium itself is therefore readily obtained; indeed, till within the last half century, the very existence of such a metal was not even thought of, much less its extraction. It is to the deep researches and labours of Davy that a knowledge of the earthy metals is due, many of them having been discovered by him, and though he himself did not actually produce aluminium from alumina, yet it was ultimately obtained by others working on the discoveries which he had initiated.

In close connection with these earthy metals are the alkaline metals, sodium and potassium, the basis of the alkalies soda and potash ; and as these substances—more especially sodium—play a very important part in all the practical processes for obtaining aluminium at the present day, I will ask your attention while I enter shortly upon the history and the means which are now adopted for their production.

Sir Humphrey Davy, in a paper read before the Royal Society, in 1807, made known his discovery of the alkaline metals. He employed what was then a novel agent, voltaic electricity, and by its means decomposed both potash and soda, producing their metallic bases, potassium and sodium. For those important discoveries, on which the science of modern chemistry may be said to have taken its rise, the French Academy conferred upon Davy the prize of 50,000 francs offered by the Emperor Napoleon for researches in electricity. But though Davy did not succeed in separating by electricity aluminium from its compounds, yet electricity was the means of obtaining it by chemical decomposition, it having been the first source from whence sodium and potassium could be obtained. In this manner, however, they could be produced only in very small quantities, and at an enormous cost. Gay-Lussac and Thénard afterwards made researches in reference to these metals, and succeeded in producing them by direct chemical reaction, but still only in small quantities as laboratory experiments. Subsequently their researches were carried further by Mitscherlich, Brunner, Donny, and Mareska ;* and, following and improving on their labours, M. Deville,† in France, liberally supplied with funds for the purpose by the present Emperor of the French, to carry out researches for the production of aluminium, succeeded in producing sodium in large quantities, and at a price which, though high, was reduced sufficiently low to enable it to be employed in the production of aluminium, at a cost which admits of its commercial use in the arts for certain purposes, though too high for general use. To enter at length into the description of the methods adopted by M. Deville would occupy too much of your time. Those who are desirous of entering more minutely into these methods, will find them detailed in the papers by M. Deville, in the Annales de Chimie indicated in the notes. They may be described shortly as consisting of heating at a high temperature a mixture of carbonate of soda, coal dust or charcoal, with chalk, in an iron vessel, when certain re-actions take place, and the sodium, which is very volatile, comes out in vapour, which, by means of receivers of a suitable form, is condensed, and then runs out in a continuous stream into vessels placed to catch it. It is through the modifications introduced by M. Deville in the forms of the receivers, and the introduction of chalk into the process—which seems to facilitate the reduction in a remarkable manner—that the production of sodium has been rendered more easy and less costly.

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* Recherches sur l'Extraction du Potassium, par MM. J. Mareska et F. Donny. Ann. de Chimie, ser. 3, tom. xxxv., p. 147.

† Recherches sur les Métaux, &c. Ann. de Chimie, ser. 3 tom. xliii. p. 19, et Memoire sur la fabrication du Sodium et de l'Aluminium, par M. H. Sainte-Claire Deville. Ann. de Chimie, ser 3, tom. xlvi. p. 415.

I have dwelt, in the first instance, on the production of sodium, because it plays an all-important part in the reduction of aluminium itself, as will be hereafter shown. It may be shortly stated, in round numbers, that it requires, according to theory, about three parts of sodium in order to produce one part of aluminium, and hence the absolute necessity for a cheap production of sodium in order to get cheap aluminium. Though Davy has succeeded in obtaining, through the agency of the galvanic battery, the metallic bases of other earths, he failed in producing aluminium from alumina, nor was he able to produce it chemically by the reaction of potassium. Berzelius and Oersted were not more fortunate in their attempts, until the latter hit upon the expedient of converting the alumina into chloride of aluminium, and then treating it with the alkaline metals. Wöhler[*] repeated the experiments of Oersted, but it was not until he had materially modified the process, that he was successful in obtaining the metal from the chloride of aluminium. In 1854, Deville, assisted, as I before said, with funds from the Emperor Napoleon, took up the subject, and it is to him that we owe the vast improvements in the process which have enabled the metal to be produced in quantities and at a price permitting it to be brought partially into use commercially. Until this time the production of the metal was simply in very small quantities, the result of laboratory experiments. Deville showed how it might be produced on a large scale, and at a very considerably reduced cost. The previous experimenters had used potassium as the reducing agent. Deville substituted for it sodium, a metal somewhat easier of production, less difficult in manipulation, and, above all, having for its chemical equivalent 23 instead of 39, and therefore rendering the use of little more than half the quantity of this expensive material necessary to produce the same amount of aluminium; and as the main element of expense in the process was the amount of alkaline metal employed, this, as well as the improvements which he introduced in the manufacture of the sodium itself, as has before been shown, was a very important step in the practical production of the metal. Deville also felt convinced that the platinum vessels which Wöhler employed affected the properties of the aluminium produced, and he substituted vessels of porcelain with success. To produce the chloride of aluminium, Deville forms a mixture of alumina (prepared by calcining ammoniacal alum), and charcoal, made into a paste, with oil, which is heated to a red heat in upright tubular retorts of fire-clay, similar to those used in the manufacture of gas for lighting purposes; and whilst in this state a current of chlorine gas is caused to pass into the retort, when chemical reactions take place, and the chloride of alumina comes over in the form of vapours, and is received in appropriate vessels, where it is condensed. The following is the method adopted by Deville for reduction of the metal from the chloride, and is thus described by the Rev. John Barlow, F.R.S., the Secretary of the Royal Institution, in a paper read before the members of that body in 1856, when Deville was present, and assisted in performing the experiments with which that lecture was illustrated:—

"A tube of Bohemian glass, 36 inches long, and about one inch in diameter, was placed in an empty combustion-furnace, constructed for the purpose. Chloride of aluminium was introduced at one extremity of the tube; at the same extremity a current of dry hydrogen gas was made to enter the tube, and was sustained till the operation was finished. The chloride was now gently warmed by pieces of hot charcoal, in order to drive off any hydrochloric acid it might contain; porcelain boats filled with sodium, were inserted into the opposite extremity of the tube; the heat was argumented by fresh pieces of glowing charcoal until the vapour of the sodium decomposed that of the chloride of aluminium. Intense ignition usually attends this reaction. At length the aluminium was liberated in buttons, which were found in the boat adhering to a substance consisting of the mixed chlorides of aluminium and sodium. The boat was now transferred, with its contents, to a porcelain tube, through which hydrogen gas was passed. At a red heat, the double chloride distilled into a receiving vessel, attached to the tube for the purpose; the buttons of aluminium were collected, washed with water, and subsequently fused together under a flux consisting of the double chloride.

"Another method of obtaining aluminium from the chloride has been adopted with success. It is as follows:—

4·200 grammes of the double chloride of aluminium and sodium (*i.e.*, 2·800 grammes chloride of aluminium, and 1·400 grammes common salt),
2·100 grammes of common salt,
2·100 grammes of cryolite,

thoroughly dry, and carefully mixed together, are to be laid in alternate layers, with ·840 grammes of sodium (cut into small pieces), in a crucible lined with alumina —a layer of sodium should cover the bottom of the crucible When the crucible is filled, a little powdered salt is to be sprinkled on the contents, and the crucible, fitted with a lid, is to be introduced into a furnace, heated to redness, and kept at that temperature until a reaction, whose occurrence and continuance is indicated by a peculiar and characteristic sound, shall have terminated. The contents of the crucible, having been stirred with a porcelain rod, while in their liquified state—(this part of the operation is essential)—are poured out on a surface of baked clay, or any other suitable material—the flux, &c., on one side, and the metal on the other." The cryolite here used is simply employed as a flux.

The process above described was by no means adapted for the production of the metal on a large scale commercially.

M. Paul Morin, who with M. Debray assisted M. Deville in his original researches, now uses at his factory at Nanterre certain modifications which he has introduced into Deville's process of the double chloride of aluminium and sodium, and gets rid of the necessity for the continued stream of hydrogen gas, as well as the use of the porcelain tube as above described. I believe it is due to M. Morin to state that it was he who first modified Deville's process so as to admit of the use of the crucible instead of the tube, thus enabling the manufacture to be carried out on a much larger scale.

Dr. Percy, in 1855, suggested the use of the mineral cryolite, which is a double fluoride of aluminium and sodium, as the ore from which the metal might be obtained, and accordingly in his laboratory at the School of Mines, experiments were made by the late Mr. Allan Dick, and a small piece of metal thus produced was shown at a meeting of the Royal Institution, accompanied with a few words of explanation by Faraday. Mr. Dick, in a communication to the "Philosophical Magazine,"[*] thus describes the process:—

"The first experiments were made in glass tubes sealed at one end, into which alternate layers of finely-pounded cryolite and sodium cut into small pieces were introduced, and covered in some instances by a layer of cryolite, in others by one of chloride of sodium. The tube was then heated over an air-gas blowpipe for a few minutes, till decomposition had taken place, and the product was melted. When cold, on breaking the tube it was found that the mass was full of small globules of aluminium; but owing to the specific gravity of the metal and flux being nearly alike, the globules had not collected into one button at the bottom: to effect this, long-continued heat would be required, which cannot be given in glass tubes, owing to the powerful action of the melted fluoride upon them. To obviate this difficulty, a platinum crucible was lined with magnesia, by ramming the same hard in, and subsequently cutting out all but a lining. Into this, alternate layers of cryolite and sodium were placed, with a thickish layer of cryolite on the top. The crucible was covered with a tight-fitting lid, and heated to redness for about half an hour over the air-blowpipe. When cold, it was placed in water, and after soaking for some time, the contents dug out, gently crushed in a mortar, and washed by decantation. Two or three globules of aluminium, tolerably large considering the scale of the experiment, were obtained along with a great number of very small ones. The larger ones were melted together under chloride of potassium."

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[*] Annales de Chimie, &c., 1 ser. tom. xxxvii, p. 66.

[*] Philo. Mag., 4th series, vol. 7, p. 364.

Rose, of Berlin,* about the same time experimented on the cryolite, and although he succeeded in obtaining the metal, he says:—"I never succeeded in reducing the whole amount of metal contained in the cryolite; it contains only 13 per cent. of aluminium; by operating on 10 grammes of the mineral, the quantity I have always employed, in small iron crucibles, the most successful result was 0·8 gramme. But 0·6 gramme, or even 0·4 gramme may be considered favourable. Many times I obtained only 0·3 gramme or even less." He goes on to say:—"The small amounts I obtained, however, should not deter others from pursuing these experiments. These are the results of first experiments, on which I have not been able to expend much time. Now that cryolite can be procured at so very moderate a price, and sodium, by the improvement in the preparation of which Deville has performed a most important service, will in future become so much cheaper, it is in the power of every chemist to employ himself in the preparation ef aluminium, and I have no doubt in a short time methods will be found affording a much more profitable result." "For the rest, I am of opinion that cryolite is the best adapted of all the compounds of aluminium for the preparation of this metal. It deserves the preference over chloride of aluminium and chloride of aluminium and sodium, and it might still be employed with great advantage even if its price were to rise considerably."

This cryolite† is found only in Greenland, and is furnished by nature in a rare state of purity, the aluminium being combined in it with sodium and fluorine only, neither of which exercise any prejudicial influence on the preparation of the metal. Care, however, should be used in selecting it, as many specimens contain ores of other metals.

Deville appears to have experimented with the cryolite, and adopted the following process of reduction. The cryolite is reduced to powder, and mixed with half its weight of common salt; this mixture is placed in an earthenware crucible, in layers, alternately with plates of sodium, until the crucible is nearly full. The last layer should be composed of cryolite alone, and covered with common salt. It is rapidly heated to perfect fusion, and then left to cool. The mass should be well stirred with an earthenware rod. On breaking the crucible, the aluminium is frequently found in large globules, easily separated. It always contains a portion of silicium. Deville gives no result of this process as to quantity, nor does it appear that the cryolite process has been generally adopted in France commercially, either by Deville or others, who have taken up the production of this metal, though Messrs. Tissier have carried it on, as I am informed, to some extent in their factory at Amfreville, near Rouen, but with what results I am unable to state. The process they adopt is the one which I have described above, save that they use a reverberatory furnace for the heating of the crucibles. The advantages they state are, that cryolite is not altered by the action of the air, whilst the double chloride of aluminium and sodium alters rapidly, and in the manufacture gives off deleterious gases, whilst it is necessarily high in price. Cryolite, on the contrary, is cheap, is unaffected by the air, is more easily worked, and without any deleterious fumes. The residuum, too, in the latter case, is said to be valuable. The fluoride of sodium which is formed can, it is said, at a very trifling expense, be readily converted into caustic soda, or carbonate of soda, which will repay the original cost of the cryolite. The process usually adopted in France is that which I have described above as Deville's, by means of the double chloride of aluminium and sodium, with the modifications which have from time to time been made by Morin and others, as experience has shown them to be important.

Mr. Gerhard, an Englishman, has for some little time past been engaged in experiments in reference to the cryolite process, with a view to establish the manufacture of aluminium in this country, and to produce it at a still cheaper rate than hitherto. He has adopted the cryolite process as a cheaper means of supply of the metal rather than the double chloride of aluminium and sodium, inasmuch as the cryolite is readily obtainable in large quantities, and at a very low price, whilst the double chloride of aluminium and sodium necessary for Deville's process is an artificial product, somewhat costly to prepare. Mr. Gerhard has erected furnaces at Battersea for the production of this metal, as well as of sodium, the necessary agent in the reduction of the ores; and there is no reason to doubt that with the modifications which he has introduced into the process, added to the fact that the materials for the production of sodium are cheaper in this country than in France, aluminium may be produced here at a still lower price than in France, whence the small quantity that has been used in this country has hitherto been imported.

Mr. Gerhard's process, which I have had the pleasure of seeing in operation at his works in Battersea, may shortly be described as follows:—270 parts by weight, of powdered cryolite, are mixed with 150 parts of common salt, and into this mixture are placed 72 parts of sodium, cut into small pieces. The whole is then thrown into a heated earthenware crucible, previously lined with a melted mixture of cryolite and salt, which mixture is also immediately poured over the contents of the crucible, covering them to some little depth, over which the lid is then placed. The crucible is then put in a furnace, and kept at a high red heat for about two hours. When the pot is uncovered the melted mixture is well stirred, and then poured out. The buttons of aluminium are found mingled with the slag, and may be easily melted together by heating them in a crucible with common salt. Theoretically, the amount of aluminium produced should be one-third of the weight of the sodium employed, but practically such a result is never obtained, and our manufacturers would be well satisfied with obtaining between one-third and one-fourth. This Mr. Gerhard has accomplished, though he is not always so successful. There is still some uncertainty in the process. From what I have seen, and from what I have learnt from those better qualified to judge on matters of chemistry and metallurgical operations than myself, I am led to believe that the cryolite process is the one that will ultimately be preferred to that of the chloride of aluminium. As yet, however, the process presents certain difficulties which Mr. Gerhard appears to have to some extent overcome by his method of performing the operation. I am sure he will have the hearty good wishes of every member of the Society that he may succeed in his labours to introduce a new industry into this country.

The price of this metal previous to the researches and labours of Deville was such as to render its production a simple curiosity for the scientific, and its employment in the arts, notwithstanding its valuable properties, was absolutely out of the question. Deville tells us that sodium was at one time sold as high as 1000 francs the kilogramme, and aluminium at a correspondingly high rate; these were, however, fancy and not commercial prices.

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* Philo. Mag., 4th series, vol. 7, p. 233.

† Quarterly Journal of the Geological Society, vol. 12, p. 140.

Previous to Deville's labours aluminium sold at the rate of 1000 francs for the kilogramme, or £40 sterling for 35 oz. avoirdupois; and when Deville came to England, in 1856, the result of his labours had then already caused a reduction in the price to 4s. per oz. for sodium, and £3 per oz. for aluminium. Mr. Gerhard already manufactures sodium commercially, and I believe it is due to his labours that the price of sodium has been considerably reduced. Sodium is now sold in this country at 16s. per pound avoirdupois, and two years ago the price of imported sodium was £6 sterling per pound. Aluminium, imported from France, fetches 7s. 6d. per oz., and there is no doubt that if large quantities of it were required the supply would be made at once at a considerable reduction on this, which may be termed a retail price. Looking at the enormous reduction which has in so short a time been made in the supply of this material, still manufactured on a comparatively small scale, there can be no reason to doubt that ultimately, and that probably at no distant period, it will be produced at a cost which will secure its application to numerous important uses. I may add here, that while engaged in the preparation of this paper, I have been informed, and I have no reason to doubt the truth of my information, that certain modifications are likely to be introduced into the manufacture of sodium, so as to enable it to be produced at a marvellously reduced price, which will effect in a proportionate degree the cost of aluminium.

I will now call your attention to the properties of this remarkable metal. One of its most striking properties is its extreme lightness, its specific gravity being 2·6, nearly that of glass, whilst that of platinum is 21·5, gold 19·5, silver 10·5, copper 8·96, zinc 7·2, tin 7·3; and in comparing its price with these metals this quality must be taken into consideration. Thus, for instance, in comparing it with silver, the bulk of a given weight of aluminium is nearly four times that of an equal weight of silver, and hence it will go nearly four times as far in the production of any article of commerce. Thus if one ounce of silver is required to make a spoon or any other article, the same weight of aluminium will make very nearly four such articles of equal size.

The metal is malleable, ductile, almost without limit; it can be reduced to very thin sheets, or drawn into very fine threads. Its tenacity, though superior to that of silver, is less than that of copper; but no very accurate experiments have been in this respect.

When pure, it is about as hard as silver. Its elasticity is not great. It files readily, and is said not to injure the file. It conducts electricity with great facility, so that it may be considered as one of the best conductors known, almost equal in this respect to silver, and more than eight times a better conductor than iron. It melts at a temperature a little above that of zinc, between zinc and silver. In its chemical qualities it would seem to take an intermediate rank between what are termed the noble metals and the common metals, being, as Deville states, one of the most unalterable of metals.

It might be imagined that it would as readily reassume its oxygen as it parted with it with difficulty when in a state of oxide. This, however, is not the case; it appears to be as indifferent to oxygen as either platinum or gold. In air and in oxygen it undergoes no sensible alteration, and it even resists it at the highest temperature which Deville could produce in a cupelling furnace, a temperature higher than that employed in assaying gold. Water has no action, according to Deville, on aluminium, neither at its ordinary temperature nor when boiling, nor even upon the metal at a low red heat, near its melting point. According to Professor Crace Calvert, this statement must be received with some degree of caution, as in experiments he has made he considers that oxydation does take place slowly where the metal is immersed in water for any considerable length of time. It is not affected by sulphur or sulphuretted hydrogen, like silver, nor is it acted upon to any considerable degree by any of the oxy-acids in the cold; nitric acid, whether strong or weak, at its ordinary temperature, in no way affects it, though when boiling it acts upon it slowly. Small grains of aluminium, plunged in sulphuric acid for three months, remained apparently unaltered. The vegetable acids, such as acetic, oxalic, and tartaric acids, have scarcely any effect on it at all. The true solvent of the metal is hydrochloric acid, which attacks it rapidly. It appears to resemble tin when brought into contact with hydrochloric acid and the chlorides. Its absolute harmlessness permits of its being employed in a vast number of cases where the use of tin would not be desirable on account of the extreme facility with which that metal is dissolved in the organic acids. But the effect of common agents on the metals in general use has been little studied. It is, however, known that if we boil for a very short time a solution of common salt in a silver crucible, a quantity of the metal is dissolved, sufficient to render the salt water alkaline, evidenced by its rendering red litmus paper blue. Sheet tin, heated for a few minutes in a solution of common salt, acidulated with acetic acid, is dissolved to a considerable extent, and this effect must constantly be taking place when mixtures of salt and vinegar are used in our cooking utensils; but as tin has little or no effect upon our bodies, and the salts are almost tasteless, the presence of tin in our food is not noticed.

Figuier, in his Scientific Year Book for 1858, just published, states that the caustic alkalies, potash and soda, and even ammonia, dissolve aluminium sensibly. He also states that common salt and acetic acid (vinegar), especially when mixed, attack and dissolve aluminium. He adds that the mixture of salt and vinegar for seasoning a salad, made in a spoon of aluminium, feebly but inevitably attacks it.

All these points, however, deserve to be inquired into, as there seems some discrepancy between different writers on them.

Through the kindness of my friend Professor Bleekrode, of Delft, I am enabled to show the meeting a specimen of aluminium procured from Paris, which is in a perfectly decayed state from having been immersed during five months in a solution of ordinary soap, such as is used for washing. He states that the result is quite different from oxydising or rusting.

Aluminium, like iron, does not unite with mercury, and scarcely at all with lead. It, however, forms a variety of alloys with other metals. It can be alloyed with iron, and when aluminium becomes cheaper it will be curious to see what effect mixtures of this metal with iron will have upon its quality, whether for good or for evil. It seems to unite readily with zinc; alloys of 100 parts zinc, with 10 or 25 parts of aluminium, have a lower melting point than zinc, and these have been found to give the best promise as solders for aluminium; but, unfortunately, when melted neither of them are sufficiently liquid, and do not run readily. The joints made will not bear a blow. A variety of alloys with nickel have been made, and that consisting of 100 parts of aluminium and 3 of nickel is found to work readily, and to have gained hardness and rigidity, as compared with the pure metal. The alloys, however, with copper are the most striking; they are light and very hard, and capable of a fine polish. In the same degree that copper adds to the hardness of aluminium, so does the latter, when used in small quantities, give hardness to copper, without, however, injuring its malleability. It renders it susceptible of a fine polish, and, according as the proportions are varied, the colour of the alloy becomes that of deep or pale gold. Alloys of copper with five and ten per cent. of aluminium, resemble gold perhaps more than any other metallic alloy hitherto employed. They do not tarnish sensibly by exposure to the air. Aluminium can be deposited by the battery, and by the same agent it can be gilt or silvered.

Looking at the various remarkable properties which this metal possesses, it is impossible not to see an immense variety of uses to which it may be applied. Already its lightness and colour has brought it into use for jewellery and ornaments of various kinds, bracelets, combs, pins, seals, penholders, tops of inkstands, porte-monnaies, shirt studs, harness, statuettes, candelabra, candlesticks, &c. Its ductility and fusibility render it readily stamped and cast. It works easily under the graver, and being unaffected by the atmosphere it has an advantage over silver. Its lightness renders it peculiarly fitted for spectacle-frames, eye-glasses, telescopes, and opera-glasses, to which uses it has alrealy been largely applied. It does not stain the skin as silver does. The alloys, too, or aluminium bronzes, as they may be termed, are peculiarly fitted, from the readiness with which they are worked, and their not changing under the action of the atmosphere, for the wheelworks of clocks and chronometers, as well as for the cases, too, for which the metal itself, also from its lightness, is peculiarly fitted.

Spoons, forks, drinking vessels, and covers for glass vessels may be made of it, which, even at the present price of the metal, will be much cheaper than silver, while they even possess in a higher degree those qualities for which silver has hitherto been prized. Figuier suggests its use for theodolites, sextants, and surveying instruments which have to be carried by hand, and where, therefore, lightness is important. The adjusting screws of such instruments, which, when made of silver or brass, tarnish from the contact of the hand, might with advantage be made of aluminium. Professor Bleekrode informs me that the working of this metal has, at his suggestion, been taken up by Mr. Meyer, a jeweller, at the Hague, who, amongst other things, has had a small bell cast, the handle of which, as a casting, is equal to anything hitherto done in silver. Professor Bleekrode regrets that time has not admitted of his sending it for the inspection of the meeting. Mr. Meyer's experience shows that the metal works well under the hammer, is well suited for chasing and engraving, as well as for casting. He alludes to the want of a proper solder for uniting several pieces, and has been obliged to adopt riveting, as in Paris. It has already been used by the dentist as a substitute for gold, in stopping, as well as for fixing artificial teeth, both on account of its cheapness and lightness, but the accounts differ as to its fitness.

Mr. Harrington, a dentist in the Isle of Wight, in a paper which he read before the College of Dentists in October last, states that he has used aluminium successfully for dental purposes, and entertains a high opinion of it as a basis for artificial teeth. His experience shows that after wearing it for four months it underwent no apparent change, and was perfectly free from all taste or unpleasantness of any kind. He cautions those who may employ it to be careful in using other metals with it, as even when "wrought" aluminium is used as wire for rivets or any other purposes, a galvanic action is set up, and the wrought metal is rapidly decomposed, leaving the cast metal unaffected. The metal is highly sonorous, and for musical instruments it has been suggested as specially suited. Figuier, however, says that the saliva, by its alkaline matter and salts, corrodes the mouthpieces; and that the same difficulty has been met with by dentists who have used it for stopping teeth. Experience will decide these points, on which it appears there are differences of opinion. It has been suggested that when sufficiently reduced in price it would be useful for the sheathing of ships, instead of copper, which is rapidly destroyed. For telegraphic communication its lightness and superior conducting power render it specially fitted. These are but a few of the uses to which this metal is applicable, and many more will be found, as soon as it becomes cheaper. Tubes are made of it.

The special qualities of this metal render it well adapted for coin; and, as soon as it can be obtained at a sufficiently low rate, it would make an excellent substitute for our copper coinage. Thus assuming that it can be produced for 5s. the ounce, the price of silver, then looking at its bulk as compared with silver, any coin the size of silver coin would be worth one-fourth of it, and hence an aluminium coin of the size of a fourpenny-piece would be worth one penny. Its lightness, too, would always render any mistake between it and silver impossible. A piece the size of a shilling would be worth threepence. If the price should get still lower, this would not be of any importance, the coins being tokens only, and not passing at their intrinsic value. That the price will be reduced below five shillings per ounce, is a matter which can scarcely be doubted, if we look to the enormous reduction which has been made in a very short time, and when we consider that the manufacture is as yet in its infancy. Let us not despair of its realising the price of copper, when I think I may with great safety predict that the Master of the Mint would not look upon it with disfavour.

Looking at what has already been accomplished in a few years in the production of this metal, both in quantity and price, from £60 sterling per lb. down to £6, the present price, and seeing that each day brings with it a further simplification of the process and fresh reduction of price, there is every reason to expect that at no very distant period the metal will be produced in large quantities and at very diminished rates of cost, so as to render it available for an infinity of industrial purposes. Again, we must not ignore the fact that a few sources only of the supply of this metal have hitherto been touched. There are the enormous beds of clay, containing an inexhaustible supply of this metal, literally at our feet. It is surely worth the while of energetic minds to turn their researches in this direction for a supply of this substance. It exists in a large proportion in the clays, and in some of them to the extent of one-fourth their weight. It is clearly within the range of chemistry to devise processes by which these sources of supply may be made available.

I have not entered into the chemical questions connected with the subject; it would have been impossible to have done so in the time limited to the paper, neither is it necessary. My object has been to bring before the meeting a short account of the history of this metal, the progress which has been making from time to time in its production, and at continually reduced cost; that great reduction in cost is daily going on, and the great probability, indeed I might say certainty, that it will be produced both abundantly and cheaply; to point out the very remarkable qualities of the metal, in the hope that by calling the attention of our metal workers to its value, it may ere long be introduced into our factories, and take its place among the industries of the country.

Towards the end of the last century, two philosophers might be seen watching the nervous twitchings of the legs of a dead frog. Surely there was nothing very promising in the future for their labours, but the result has been the marvels of the electrotype, and the wonders of the electric telegraph. A few years since, at one of the meetings of the British Association, there might have been seen a gentleman showing to his friends, as a curious toy, a fac-simile, which, by means of electricity, he had made of his visiting card, little dreaming that that was the beginning of the electrotype, which has added an entirely new trade to this country. I can well remember the first specimen of gutta percha being brought to England and laid before this Society. For a time it was neglected; its peculiar qualities were looked upon as of little value; little use was seen for them. One of its special peculiarities—its being a non-conductor of electricity, attracted little attention, whilst electricity itself was confined to the closet of the philosopher. We are all aware of the important part it plays in reference to that quality alone, now that electricity has become, if I may use the term, a commercial commodity. Yet what were the prospects of all these researches and labours, compared with the prospects which open up to our view when we contemplate the introduction of the remarkable metal to which I have called your attention this evening.

In conclusion, let me express my best thanks to the Master of the Mint for a medal which he has been good enough to have struck in aluminium to illustrate this paper; to Professor Bleekrode for a specimen illustrating the decomposition of the metal; to Professor Tennant for a beautiful collection of gems and minerals; to Messrs. Johnson and Mathey for specimens of the metal, its alloys, and articles made from them; to Mr. J. A. Franklin for articles manufactured from the metal; to Mr. Marshall for specimens of the metal in leaves; to Mr. Harrington for a specimen showing its applicability to dental purposes; to Mr. Whiskard for a case of jewellery made from the metal; and to Mr. Gerhard for specimens of sodium, cryolite, aluminium, and articles made from it.

DISCUSSION.

In answer to an inquiry whether he was aware of any experiments having been made as to the relative strength of aluminium compared with other metals, Mr. **Foster** replied that he did not know of any accurate experiments having been made; but he believed he might state that this metal had been found to be stronger than silver. With regard to the difficulty of finding a solder suitable for it, he had been informed that Mr. Warren de la Rue had made experiments with a solder composed of aluminium and cadmium, which seemed to promise well, but he was not acquainted with the details.

Mr. **Edward Smith Marshall** exhibited some thin leaves of aluminium, beaten out after the manner of goldleaf, some of which were stated to be of the 80,000th part of an inch in thickness, showing the remarkable malleability of the metal.

Professor **Tennant** said it might be interesting to those who were desirous of further investigating this subject to know that there was a plentiful supply of cryolite to be obtained from Greenland. Twenty-years ago he gave £2 or £3 for specimens which could now be obtained for sixpence or a shilling; and he remembered giving as much as £5 for specimens of the cryolite not larger than those which Mr. Foster had before him. In January, 1856, Mr. Taylor read a paper on this subject before the Geological Society, to which Mr. Foster had referred. It was then stated that cryolite was found at a place called Evigtok (which signified in the Esquimaux language a place of plenty), about 12 miles from the Danish settlement of Arksut. It formed a bed about 80 feet thick and 300 feet long. The cryolite was quite white on the surface, but at a depth of about ten feet was found to have a blackish hue, though free from foreign matter. He had placed upon the table a specimen of this cryolite, showing carbonate of iron and other metals in combination with it. There were also found in combination with cryolite crystals of tantalite, or oxyde of tantalum, sulphuret of molybdena, galena, which was rich in silver, yielding 40 ounces to the ton, blende, carbonate of iron, iron pyrites, fluor spar, felspar, quartz, mica, hornblende, and other minerals. Black cryolite, heated to redness, was found to lose about one per cent. (moisture and acid), the whole of its colour, and part of its translucency, becoming perfectly white, like that at the surface. Whilst referring to those minerals which contained aluminium in greater or less quantities, it was to be remarked that corundum furnished some of the finest gems that were known. The fine blue corundum was the oriental sapphire; the red, the oriental ruby. The gems of commerce, such as the common topaz and ruby, differed from those to which he had alluded, these being the coloured varieties of the corundum.

The **Chairman** said he quite agreed with Mr. Foster and M. Deville, that the place which aluminium held in the scale of metals was that of an intermediate metal between the precious metals and the commoner ones. He thought it rather stood at the head of the common metals than at the bottom of the precious metals; and M. Deville had pointed out the singular analogy which existed between it and iron. At first sight it did not exhibit much resemblance to iron, but it resisted the action of nitric acid in the same way that iron did, and was also somewhat magnetic, and acquired by pressure the elasticity of that metal. The most curious fact connected with it, perhaps, was its property of combining with carbon and silica. When this combination took place a substance was formed analogous to cast-iron, brittle and friable. The analogy of this metal with silver was indeed rather more apparent than real. The noble metal silver was reduced by heat alone, which was not the case with the oxyde of aluminium. It was possible that ultimately a lower oxide of this metal would be discovered, a protoxyde of aluminium analogous to the protoxyde of iron, which would doubtless admit of a great variety of applications.

Mr. **Newton** was desirous to know whether Mr. Foster had seen any instances in which aluminium had been employed for any of the purposes enumerated in the paper, such as wheels of clocks, sextants, and other mathematical instruments, or in any position in which there was any considerable amount of friction. It was important to know what effect friction had upon this metal. He conceived that aluminium would not be suitable for the joints of mathematical instruments that were subject to considerable abrasion, and even silver itself was found to be inapplicable to those purposes. Theodolites and similar instruments had been mentioned as one purpose to which aluminium, owing to its lightness, could be applied, but for some parts of these instruments gun metal was now employed, because brass was too soft for the purpose, and he very much questioned whether so soft a metal as aluminium was applicable to such purposes. For some articles, such as opera glasses and spectacle frames, he had no doubt it was very suitable.

Mr. **Samuel May** had given some attention to the manipulation of this metal, but he had found several difficulties connected with it, which he feared were insuperable in the application of it to many useful purposes. The great objection appeared to be that alluded to by the last speaker—that was its extreme liability to abrasion. There were, however, purposes to which this metal might be usefully applied, of which mention had not yet been made, and it struck him that it might supply a want which was very much felt amongst medical men—namely, a receptacle for caustic. Gold was generally employed for that purpose, but it was heavy and expensive. Within the last few years, palladium had been substituted for gold for this purpose, but the supply of it was very small. Aluminium seemed specially adapted for this purpose, owing to its power to resist the action of strong acids. The great difficulty was the want of some means of uniting the metal without the necessity for riveting. At present no solder had been discovered, and that was one great difficulty in the way of its application to many useful purposes. He had found, however, that aluminium held a good thread for a screw, and this method of union might, therefore, be employed in cases which admitted of it. He had no doubt that the scientific researches of the age would eventually overcome these difficulties, and he could assure those who were desirous of investigating the subject further, that it was one that would amply repay them for their labour.

Mr. **Charles H. Smith** remarked that a good deal had been said with respect to the cost of this metal. There was no doubt that any new metal was very expensive upon its first introduction, and even now, if any person wanted to procure an ounce or two of iron direct from the ore, and was not acquainted with the means which lengthened experience had taught them, it would be rather an expensive matter. When a new and useful metal such as this was discovered, it was impossible to set limits to the purposes for which it might ultimately be found to be applicable, and whenever its real value became known, enough of ingenuity would spring up to discover the means of producing it at a low rate. With reference to the question of cost, he could remember the time when the first lucifer matches were introduced, and it was then thought a great thing to be able to obtain 100 of them for a shilling, and they could now buy 10,000 for the same sum, and these of a very superior quality. If this metal could be supplied at a cheap rate, its peculiar properties would render it invaluable in supplying a great want in the present day—that was, a cheap and durable covering for the roofs of houses. At present slate and lead were employed for that purpose, but the former was very heavy, and the latter was not only very heavy, but open to other serious objections.

Mr. Foster would state, in reply to what had fallen from Mr. Newton, that he had not said that aluminium was itself suited for the wheels of clocks, but the bronze of aluminium and copper, which had been used for that purpose. He believed a watch with works made of this bronze was exhibited at the Paris Exhibition. A specimen of it, made by Dr. Percy, was sent to Woolwich Arsenal a year or two ago, and experiments were made upon it. It was found to be very hard, and much superior to the ordinary bronze of tin and copper. In fact, the observation was made that if it could be produced at a sufficiently cheap rate it would form an excellent material for cannon.

Mr. William Hawes said this was too important a subject to be dismissed with the few observations that had yet been made upon it, and he would refer to one or two subjects which struck him during the reading of the paper. The great object in bringing before the Society a subject like this was, not only to elicit facts in support of the statements made by the author of the paper, but also to bring out all the objections that could be adduced. Up to the present moment, all the opposition that had been made to the views of Mr. Foster, as to the probable introduction of this new metal for the ordinary purposes of life was, that there were no precisely ascertained facts as to its strength. It was suggested by one speaker that its softness rendered it unfit for certain appliances, and the meeting was led to infer that therefore it would not come into competition with the older and more common metals. Supposing it to have failed in the instance of the balance wheel of a watch, this ought not to induce a doubt that so important a discovery as this would have a considerable effect upon the mechanical arts of the country. Many years ago he was in the habit of bringing sodium from Paris for Professor Faraday. It was then difficult to obtain in this country, and the price he paid for it in Paris was £26 per pound, and it could now be procured for 16s., with every prospect of that price being yet considerably further reduced. If, therefore, they had had such a reduction in the price of a metal not so useful as aluminium itself, what might they not look forward to with regard to reducing the cost of this confessedly useful metal. The price had already been reduced from £5 or £6 to 7s. 6d. per ounce, and might they not infer that the 7s. 6d. would be reduced almost in the same proportion as had been the case with sodium, which fell from £26 to 16s. It was not of importance to consider at the present moment whether or not it was applicable for the works of a watch, there were so many other purposes for which it was adapted. They must not forget that, although this metal was now produced from a particular mineral brought from Greenland, it also formed the main constituent of the great bed of clay on which London rested. He thought they were very much indebted to Mr. Foster for the manner in which he had brought this interesting and important subject before them, and for directing particular attention not only to the valuable properties of the metal itself, but also to the progress that had been made in a very few years in reducing the cost of its production.

Mr. Robert Thomson said there were two statements made in the paper which appeared to be scarcely reconcilable with each other. He alluded to the circumstance mentioned by Mr. Harrington that, whereas aluminium had been applied to dental purposes, and had been in use for four months without oxydising, yet in the case of mouthpieces for musical instruments oxydation had been found to take place to a considerable extent.

Mr. Foster said that in reference to the latter statement he had quoted from a work just published by M. Figuier.

Mr. Thomson added that Mr. Harrington stated in his paper read before the College of Dentists, that if the aluminium were forged it would oxydise in the mouth, but if it were cast this would not occur. The difference might consist in the method of manipulation. It was also stated by Mr. Harrington that if any other metal—such as spiral springs of gold—came in contact with the aluminium in the mouth, a galvanic action took place, and destruction of the aluminium was the consequence. This had been obviated by insulation with tortoiseshell.

Mr. Strode mentioned that efforts were being made in Denmark to produce this metal in large quantities, for which purpose the cryolite was imported from Greenland. A friend of his, who was pursuing the subject, had asked him whether there was any means of disposing of the residue of the manufacture.

Mr. Palmer thought if this metal would admit of sufficient polish, it would form a valuable substitute, owing to its extreme lightness, for the tin and glass at present used for daylight reflectors. Another useful application of the metal, he thought, would be as a lining for packages for shipment, inasmuch as the lighter they were the less would the freight be. He had no doubt that in a few years it would take a place of equal importance in our manufactures to that which gutta percha had taken, and he thought they were very much indebted to Mr. Foster for having brought so interesting a subject before them.

Mr. Frederick Lawrence could not agree with the opinion that the only bar to the more general use of this metal was its high price. When it was at the price of £2 per ounce, people had said that if it could be reduced to 10s. an ounce, there would then be plenty of it used; but although it was now 7s. 6d. an ounce, it had not come into general use. One serious drawback was that it could not be joined by soldering; and further, he found that manufacturers were not likely to employ it for many of the purposes for which it had been suggested as applicable. One speaker had said that it would not answer for mathematical instruments; and another that it would not do for the wheels of clocks. At present they had not heard of any description of manufacture to which it was applied at the present price of 7s. 6d. per ounce, except, perhaps, articles of jewellery, such as those on the table. Silver was expensive, yet it was extensively employed in our manufactories; if, therefore, it was merely a question of price, why was not aluminium more generally used. Judging from the spoons exhibited, he thought there was little chance of this metal being used for that description of domestic article. He thought the value of this metal would be greater as an alloy with other metals than as a pure metal, and experiments with it as an alloy with iron would, in his opinion, be very valuable.

Mr. Gerhard mentioned that he had had an application for 500 ounces of aluminium at 3s. 9d. per ounce, which he intended to accept.

In answer to an inquiry whether this metal had been precipitated by galvanic action,

Mr. Foster stated that it had, and, moreover, that gold and silver had been precipitated upon it.

Mr. Elliott thought it was no discredit to the present assembly that the discussion of this subject had not been of a more extended character, inasmuch as little was known of this new substance. A great deal of information, however, had been laid before them in the present paper, for which he begged individually to express his thanks to Mr. Foster. He thought it a very wise maxim never to speak upon a subject with which one was not acquainted; and it was a proof of the wisdom of the members present that so little had been said, for the best of all reasons, that but little was known. An example had been set here to-night which he thought all talking public bodies would do well to imitate, namely, never to talk unless they knew something of what they were talking about.

The Chairman would close this discussion by expressing, on behalf of the meeting, the gratification which they had derived from the paper read by Mr. Foster, and the able manner in which he had treated the subject. He begged to propose a vote of thanks to Mr. Foster for his paper.

The vote of thanks was then passed.

The Secretary announced that on Wednesday evening next, the 9th instant, a Paper by Mr. P. L. Simmonds, "On the Utilisation of Waste Substances," would be read.

THE ECONOMIC MUSEUM.

This collection, which has been formed in the name of the Council of the Society of Arts, by Mr. Thomas Twining, one of its Vice-Presidents, is now open in an advanced state at the Royal Polytechnic Institution. It is intended to form a repertory of useful knowledge for every-day life, so as to show what may be done with limited means and in a comparatively small space, towards realising in a permanent form the scheme of popular instruction and sanitary improvement, which was so successfully carried out in the form of a temporary Exhibition at Paris in 1855, at Brussels in 1856, and subsequently at Vienna and Feldsberg. It is intended to impart to all classes of the community, and more particularly to those whose income is small, that knowledge of common things which is so essential in their every-day life; teaching them what sort of dwellings they should live in to secure health and comfort, what improvements in domestic economy they may derive from the discoveries of science or borrow from the customs and appliances of other nations, what fabrics they should wear, what food they should eat, and how it ought to be cooked; how they may distinguish things which are genuine, wholesome, substantial, durable, and really cheap, from those which are good and cheap only in appearance, and in short, how they may live with judgment, and get the best money's worth for their money.

Arrangements have been made for the delivering of popular and well-illustrated lectures in every branch of the practical philosophy of common life. Minor oral explanations of the articles displayed will be daily given by competent attendants. Moreover, an essential feature of the Economic Museum, is its system of instructional labelling, whereby reference to a catalogue is entirely dispensed with, and the acquisition of useful knowledge made easy to every visitor.

Benevolent persons will find in the Economic Museum an amount of practical information not united elsewhere, for their guidance in the improvement of the dwellings and household comforts of the poor, or in the organisation of provident or charitable institutions. Indeed, the whole of the collection is formed strictly for purposes of social improvement and Christian benevolence, and therefore visitors who may notice deficiencies which they can assist in supplying, or who may otherwise be inclined to co-operate in this undertaking, are earnestly invited to communicate with the curator.

Inventors, manufacturers, and others will be afforded every facility for the display of articles deserving of being recommended to the notice of the public for general adoption.

When fully developed, the Economic Museum will, it is hoped, form a medium for the interchange between Great Britain and the Colonies, and other countries, of inventions, contrivances, publications, and authentic information bearing on the physical and intellectual improvement of the people; and the Museum Library will become a centre for international correspondence on all matters connected with the well-being of the industrious classes, according to the plan recommended by the Philanthropic Congress held at Brussels in 1856, and of which the realisation is now progressing under the direction of the eminent Belgian philanthropist, M. Ducpetiaux.

The collection is divided into several classes, some of which include building designs, materials for building, furniture, and other household requisites suitable for the working classes, while others embrace clothing, food, medicine, and the means of obtaining light and warmth, as well as various sanitary appliances. Other departments are devoted to the subjects of home education and recreation, while in the Economic Library, which has been added to the Museum, are found various books, pamphlets, and documents (British and foreign) relating to matters of domestic, sanitary, educational, and social economy, and practical benevolence, and especially intended for the use of persons engaged in the organisation of Provident and Charitable Institutions, and of clergymen, medical men, schoolmasters, and others intrusted with the bodily welfare or intellectual guidance of the people.

Programmes of the Museum may be obtained on application to the Secretary of the Society of Arts.

COTTON CULTIVATION IN OUDE.

The following observations on this subject are by Mr. L. E. Runtz Rees, author of the "Personal Narrative of the Siege of Lucknow:"—

"I feel it particularly deserves the attention of those who take an interest in the growth of cotton, to remark how peculiarly Oude is fitted for its cultivation. The best proof of this is that no inconsiderable quantity has been exported from it, even during the mismanagement of the native government, which affected cotton in the same way as, or even more than, the other natural products of Oude. The immense importance of a supply of cotton from India (the only one of our colonies that seems capable of producing it in sufficient quantities) is fully appreciated by our manufacturers, whose very existence as such depends on an independent and regular supply of that article. Its successful growth, we must consider, depends upon both the soil and the irrigation. Both the rich black soil and the more meagre red, which is, in the opinion of many, quite as fitted for the growth of cotton, exist in Oude, particularly in many of the jungles. These, however, might, and should, as I have already pointed out, be made available for purposes of cultivation. Indeed, one firm, Messrs. Burns and Co., I understand, have actually undertaken the contract to clear the Jugdeespore jungle, the fifth in my list. There is sufficient water in the streams and rivers in Oude, which have the further advantage of not being like the Ganges and other rivers, fifty to a hundred feet below the level of the soil; the natives being thus enabled, with even their rude implements, to attend to its cultivation with greater facility than in most other parts in India. But I see no reason why, when European science is brought to bear upon native enterprise, this advantage could not be turned to still further account. European supervision is not so much required for its production as for sugar or indigo. Unlike those, cotton is the raw produce of the tree, and with the increased facilities for transport which must arise, the native would easily be induced to pay sufficient attention to its cultivation to render it equal to any other kind of cotton. The only serious obstacle to the production in sufficient quantities to supply all the demands of our markets is the defective and costly means of transport, nowhere so apparent as in Oude, which not only prevents the native from successfully competing with the American in delivering cheap cotton at a seaport, but also materially damages the quality of the article. The natives of India consume about 2,000,000,000, while the amount exported to all other countries does not exceed 150,000,000 pounds. These figures prove that in India cotton is not grown for exportation, but for home consumption, and that the native agriculturist, possessed of no capital, and loaded with debt, as he is everywhere in India, and oppressed arbitrarily as he has been, particularly in Oude, cannot and will not take the risk of seeking a market elsewhere than on the spot. In some parts of Oude, cotton was produced at even less than an anna (1½d.) per pound. With steamers on the Gogra, good roads throughout the country, and a railroad through the heart of it, no doubt whatever can be entertained that Oude may be made one of the most important cotton-producing provinces in India; nor is the fact to be questioned that India is capable of furnishing any quantity that may be required."

UNITED SERVICE INSTITUTION.

On Friday, the 28th of January, a memoir was read at the United Service Institution, by Mr. Hyde Clarke, on Indian Military Defence. The object of the paper was to show that in consequence of the adaptation of the healthy hill regions of India to European constitutions (a subject which he had treated in a paper read before the Society of Arts last session[*]), the military system should henceforth be based on the occupation by English troops and colonization by English settlers of these hill regions, so that India may be held by an English army instead of by a native army, in the tropical cities liable to revolt. Mr. Clarke showed that the Himalayas, the Vindhyas, the Ghauts, Neilgherries, Shevaroys, and attached table lands could support a large body of English settlers with an abundant supply of cheap native labour. He urged the extension of the Madras line to the Neilgherries, of the Northern Bengal Railway to Darjeeling and Assam, and other lines, as an important auxiliary measure. The hill regions, so occupied, would, he pointed out, become a barrier against the aggression of Russia by land, or of France by sea. The approximation of the Chinese frontier to Assam had now become important, as millions of Chinese emigrants might enter from that quarter.

LIFE-BOAT EXPENSES.

During the past year the Royal National Life-boat Institution has incurred the following expenses, on either additional new life-boat stations, or the replacing of old boats, transporting carriages, and houses, by new ones:—Norfolk—Cromer, £276 16s. 5d.; Mundesley, £223 9s. 5d.; Bacton, £377 11s. 11d.; Palling, £272 17s. 6d.; Winterton, £400 5s. 11d.; Yarmouth (two boats), £859 3s. 5d. Suffolk—Lowestoft, £153 14s. 6d.; Southwold, £127 19s. Berwick, £73; Boulmer, £73; Alnmouth, £41; Whitburn, £247 1s.; Hornsea, £44 12s.; Exmouth, £140 1s.; Appledore £44 12s.; Aberdovey, £138 3s. 1d.; Rhyl, £52 17s., Penmon, £72 15s.; Fleetwood, £140 1s.; Fraserburgh £255 2s. 2d.; Lossiemouth, £140 1s. Ireland—Newcastle County Down, £282 7s.; Dundalk, £191 1s.; Kilmore, £140 1s.; Carnsore, £187 8s.; Tranmore, £322 18s. 9d.; Dungarvan, £191 1s.; and Ardmore, £81 11s. 5d. The Institution has also expended on the repairs, stores, alterations, and inspection of its numerous life-boats, boat-houses, and transporting carriages, £2,714 5s. 3d., making altogether a total of £8,265 3s. 9d. It has also granted, during the same period, £952 as awards for saving 427 persons from 64 wrecks on our coasts. This national work has, however, only been accomplished by involving the society in a debt of £3,047, and an expenditure of £1,000 from its small reserved capital. It has now eighty-one life-boats under its management, and to maintain these in a state of thorough efficiency, a large permanent annual income is absolutely needed, if its humane mission is to be perpetuated.

CONVEYANCE OF RAILWAY TRAINS ACROSS THE CHANNEL.

M. Fromage, of Darnetal (Seine Inférieure), proposes to complete the communication between the railways of England and France, by means of very large steamers, capable of conveying a railway train across the Channel. On the arrival of a train at Calais, he proposes that it should be run on to the deck of the steamer, secured, and conveyed across the Channel to a basin in Dover, where he proposes to run the French train on to the English railway, and send it on to London. The return train, on its arrival at Dover from London, he proposes should be run on to the deck of one of those large steamers, secured in its position, and conveyed across the Channel to Calais, where, by means of certain apparatus, it could be landed on the French railway, and conveyed by locomotive power to Paris. He considers this mode of railway communication practicable, easily accomplished at a moderate cost, and far superior to any scheme having for its object the construction of a tunnel under the sea, or a tubular bridge over the Channel.

Home Correspondence.

EXHIBITION OF 1861.

Sir,—Since I addressed you in September last on the question of *site* for the proposed International Exhibition of 1861, and advocated that of Kensington Gore as in all respects the most eligible, the claims of the Crystal Palace at Sydenham have been pressed on public notice. Much has been written on both sides, and until the Council of our Society are in a condition to entertain and decide upon it, much may yet be urged by parties more or less interested in the solution of the question. In the hope that I may be able to direct attention to some serious, not to say fatal objections to the Crystal Palace, which appear to have been overlooked, and to one or two points in favour of Kensington, I once more enter the lists.

It appears to me that to render the proposed Exhibition popular, and therefore self-supporting, if not also profitable in a pecuniary point of view, the following, amongst other minor desiderata, are necessary, so far as site only is concerned.

1st,—It must be easy of access and egress.

Can this be affirmed of the Crystal Palace? The distance from London is alone a formidable impediment, and renders railway or other means of conveyance indispensable, both of which involve time and expense.

Take the first of these—Time. If visitors go by private conveyance, it is not, I think, too much to assume that at least two hours would be consumed, or four hours going and returning. If by rail, the time occupied on ordinary occasions from station to station, including the payment for tickets, is about three-quarters of an hour, or one hour and a half going and returning. But on days of extraordinary attraction, when from 20,000 to 30,000 are seeking conveyance by this channel, I know, from experience that the time lost at London-bridge station is more generally an hour than less. Then, on arrival at the Crystal Palace station, we have a long ascending passage to walk, and nearly 200 steps to climb, before reaching the Exhibition, which consumes time, and is to most people a serious physical impediment. But all this is as nothing compared with the difficulties of egress. Think of thousands of persons on such days, many women and children, crammed together, and on their feet, either in the open garden, or in a long covered avenue, for one or two hours or more, at the close of a fatiguing day, before they can reach the railway platform; and when there to have to encounter the dangerous scramble for seats as empty trains arrive; parents separated from children, husbands from wives, &c., deeming themselves fortunate if they can find space in any carriage and in any company, rather than again encounter the horrors of the "middle passage." On arrival at the metropolitan terminus their troubles are not over; for at the late hour they reach it, cabs, being engaged at the theatres and other places of amusement, are comparatively scarce, and the omnibuses are generally insufficient for the convenience of the multitudes requiring conveyance home. All this is bad enough in fine weather, but when unfavourable from wet, or heat, or both, the aggravation of these annoyances may be better imagined than described.

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[*] See *Journal*, Vol. VI., p. 323.

If all this applies to the City terminus, what can we say of the new one at Battersea, where, on alighting, the exhausted pleasure-seeker may look in vain for further travelling accommodation, the few cabs venturing to that obscure region being soon snapped up? It may be, however, that before 1861 additional railway facilities to and from the Crystal Palace may be opened up, but this is a possibility on which (assuming all other objections to be overcome, but most of which are absolutely inherent,) it would be dangerous to calculate, for even under the most favourable conditions, the numbers flocking to the Exhibition, taking the facts in that particular of 1851 as criteria, would be more than treble the number of those who visit the Crystal Palace on ordinary occasions, and more than double of those who are gathered there when extra attractions are presented. I believe the greatest number who ever entered it on one day was 37,000,* while at the Great Exhibition the average attendance on the 80 shilling days was 55,493, and on one occasion it reached the almost fabulous number of 109,915. Imagine such a crowd at the Crystal Palace for a single day; if with 30,000 visitors large numbers are detained there until 10 p.m., it would be daylight before these additional victims would be released from their imprisonment.

Take another view of this difficulty. Suppose that 109,915 persons contrived to obtain admission to the Crystal Palace in one day, and that those who must return by rail desire to leave between 3 and 8 p.m., and that a train left the station every five minutes; it would be necessary that each should convey about 2,000 passengers, if, which is a necessary condition, they could take their seats in that small fraction of time. This assumes, also, that passengers are willing to begin returning at the early hour of 3 p.m., when, and long after, many visitors are only arriving. But as in all probability, and, indeed, as at present, few would be disposed to leave before 5 or 6 p.m., the impossibility of all departing before midnight, if then, is sufficiently clear. On the point, then, of access and egress, facts seem to be conclusive against the Crystal Palace.

2nd. The expense, if any, of access to and return from the Exhibition should be inconsiderable.

An Exhibition of manufactures and art, being essentially educational, should be within the means of the many. Can this be said of the Crystal Palace, under the most favourable circumstances? I think not; for supposing any charge to be incurred for conveyance, it must be in addition to that for entrance, to say nothing of the extra time occupied in going so far from London, which to most people is money.

By far the greater number of those who visited the Exhibition of 1851, went and returned on foot, having then only the entrance charge to pay; they were not obliged to start early and leave late. By this double economy of time and money, they could visit it more frequently, and therefore profit more largely by the great lessons it silently taught. Who that was privileged to go often to the great displays of 1851 and 1855, could have failed to witness with interest, on shilling days, the eager anxiety of the humbler classes to understand the mysteries of productive science as developed in working machinery and the vast resources of new or improved engineering and other suitable apparatus, exposed for the first time to minute public scrutiny? To deprive these classes, then, of such extraordinary sources of congenial gratification and improvement, or even to curtail them by unnecessary pecuniary difficulties, would be almost, if not quite, a crime.

Assuming, however, for the moment, the possibility, as has been suggested, of an arrangement by which this portion of the public could be conveyed by rail and admitted to the Crystal Palace at a charge of one shilling, the important element of time remains to be dealt with. As I have already shown, it is an insuperable difficulty, unless, between now and 1861, some extraordinary means of conveyance scarcely less rapid than the electric telegraph should be devised. I have great faith in the as yet undiscovered resources of science, but it has not yet reached this point.

If the Railway and the Crystal Palace Companies are to be paid out of this charge of one shilling, what proportion will remain to defray the cost of erecting a building in Dulwich-wood, as proposed by the directors of the latter, for the reception of paintings and other delicate works of fine art, the re-modelling of the Crystal Palace itself, and its reinstatement when the International Exhibition is over? And what will remain out of the gross receipts, after the discharge of these liabilities, from which to refund the expenses attendant on the preparation and general management of the Exhibition?

I think I may now pretty confidently assume that, in the important items of time and expense, the distance of the Crystal Palace from London takes it out of the second category of desiderata?

3rd. The building should be suitable for the reception, arrangement, and display of the varied and valuable articles which an International Exhibition must contain.

As regards mere extent of surface, it is probable that the Crystal Palace would afford adequate accommodation, but to render it really available, the greater part of its present contents must be removed at a large expense of labour, and at the almost certain destruction of a very considerable portion of the valuable and important collection of imitative ancient, mediæval, and modern art, with which it is now adorned, and which constitutes its best permanent attraction, and when all this is done will it be suitable for the safe display of those delicate and fragile creations of genius, viz. art of all countries, schools, and ages? To say nothing of the almost absolute impossibility of making an enormous glass building impervious to rain, and able to resist such storms as sometimes visit our climate, the great heat in summer would endanger the preservation of oil paintings. I say "endanger," because I know, of course, that pictures are now exhibited in one of the galleries of the Crystal

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* This was on the great "Guides day." I have an impression that on the last "Foresters' day" this number was exceeded, but have not the means at hand of verifying the fact.

Palace, but it is I presume only an experiment thus far, and I am quite sure that the possessors of such treasures of this class, as we are encouraged to expect will be placed at the disposal in 1861 of those who will be responsible for their safe return, will absolutely decline to lend them for exhibition where any—even the remotest—danger of damage should exist. As I have already incidentally observed, the present arrangements of the Crystal Palace as regards exhibiting space, are unsuitable, and would require extensive alterations and additions, the cost of all which when added to the charge to be made for the exclusive tenancy of the building, would go far towards the erection of another, every way convenient, in a more suitable locality.

As a 4th requisite, I might add the importance of a site where the facilities for the reception of goods are easy, safe, and inexpensive, but as much of what I have suggested under the second head is equally applicable to this, it is not necessary that I should further urge it.

Before I quit Sydenham and turn for a moment to the site of Gore-house, which I have always advocated, I have a few words to say respecting the prospects of the Crystal Palace Company, in the event of the offer of the use of their premises, under certain conditions, not being accepted.

Between 1851 and 1861, some 3,000,000 of the population of the United Kingdom, who at the time of the first Exhibition were too young to visit it, will have arrived at an age to appreciate the contents of a new one. Stimulated as they will be by the traditional wonders of that of 1851, by the increased attractions of that of 1861, and assisted by additional railway facilities all over the country, a large proportion of them will probably visit it. Of all these, and of all others who will come to London in that year, it would not be too extravagant to expect that at least one-half would not leave without a visit to Sydenham. As to them the ordinary attractions of the Crystal Palace would be new, and afford ample temptation to spend at least one day there, the directors would be spared the expense of those additional sources of amusement which seem just now to be indispensable. The non-introduction of these novelties will tend to spread the daily visits of strangers more equally over the time the Great Exhibition of 1861 will remain open. This will ameliorate to some extent the difficulties of ingress and egress which now exist, and which I cannot doubt will be still further provided for, to the greatest extent of which it is susceptible.*

In 1851, all exhibitions and places of amusement profited largely by the enormous influx of strangers to London. I think, therefore, that taking all these considerations into account, if I were a shareholder in the Crystal Palace Company, I should prefer to decline letting the Palace for the purposes of the ensuing Exhibition, and take my chance of what profit might accrue from the foregoing additional sources.

As between Sydenham and any other locality than Kensington Gore for the Exhibition of 1861, there is now, I believe, no question. And, as the site of the latter has already been advocated by me (see *Journal* for Sept. 17th, 1858, p. 642), and subsequently by abler pens than mine, it is not necessary that I should now remind your readers at any length of the considerations in its favour, especially as the more important of them are tolerably obvious, and may be comprised in a few words.

Kensington, as a suitable locality for the purpose, has been already tested. In 1851, the Exhibition was, as we know, visited altogether by 6,063,986 persons, and, as above mentioned, nearly 110,000 entered and left it without inconvenience in one day. Of this vast number comparatively few availed themselves of carriage conveyance; and for those who resided at too great a distance to walk, or could afford the expense, vehicles in abundance were immediately at hand. It enjoys, then, the prestige of actual experience, and, as a writer in the *Globe* of 22nd Dec., 1858, very truly says, "It is accessible from many leading thoroughfares; it is not far distant from our railways, and if any of the plans for uniting the London and North-Western, the Great Western, and North London Railways with those on the south side of the river, which are already deposited and advertised to be brought before Parliament in the session about to be opened, can be carried out—and some such plan must be carried out—the goods from our great seats of industry might then be delivered at once by means of a short branch line on the grounds of the Exhibition itself without delay, and at a diminished cost."

I shall regret that if in urging the claims of Kensington-gore I may be thought to have depreciated those of Sydenham more than truth and the exigencies of my argument required, and can only say that such was not my wish. It only remains for me to repeat that as the question of site has not yet been before the Council, I only am responsible for the views on that all-important point which I have ventured herein to propound.

I am, &c.,
THOS. WINKWORTH.

Gresham Club, Feb. 1, 1859.

SMALL PARCELS POST.

Sir,—By way of corroboration of Mr. Chadwick's statement that the system of a Small Parcels Post answers perfectly well in Switzerland, allow me to say that it works equally well in Germany and Austria, where it is carried out long since by means of the so-called *Fahrpost*, and a staff of well-equipped postmen. I have not the least doubt that it is greatly owing to that easy and safe means of establishing a literary and commercial intercourse between the members of that odd conglomeration of political bodies, that the curse of a centralization of intellectual and manufacturing power has as yet been withheld from that country, and a sound and unsophisticated mode of thinking and action been made the best compensation for the want of other more shining advantages.

I am, &c.,
A. TOLHAUSEN.

London, 31st January, 1859.

ELECTRO-ZINC DEPOSITS ON ENGRAVED COPPER-PLATES.

Sir,—M. Louis Figuier, of Paris, through the instrumentality of my friend and *confrère* M. Henri Plon, the eminent printer and publisher of Paris, having recently, in the columns of *La Presse* newspaper, made mention of my mode of surfacing engraved copper plates with a coating of pure zinc by electro-metallurgical means, for the purpose of protecting such plates from wear while printing, and which coating can be removed and renewed at pleasure with facility and without injury to the engraved plate, I beg leave to introduce the particulars of my mode, for the benefit of those interested in extending the application of the galvano-plastic art.

To obtain a deposit of pure zinc capable of printing from 1,500 to 2,000 impressions or more, before requiring to be removed and renewed, I have recourse to a combined solution of chloride and cyanide of zinc, prepared as follows:—

Chloride of Zinc Solution.—In a suitable vessel dissolve one part chloride of ammonium in eight parts water; place in this a porous cell containing the same solution and a copper plate, which attach to the zinc of

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[*] It is an ascertained fact that, in 1851, 624,000 persons passed through the London-bridge terminus: in 1858, over 13,500,000 passed through it! Assuming additional facilities to be afforded in 1861, this number will, in all probability, be largely increased. And if this is true of one London terminus, what the aggregate increase at all the other metropolitan termini, representing as they do the whole surface of the United Kingdom, and foreign visitors may be, it would be difficult to estimate.

a Smee's battery, and in the outer cell place a plate of spelter, which attach to the silver of the above battery for 48 hours.

CYANIDE OF ZINC SOLUTION.—Dissolve ½lb. of cyanide of potassium in twelve parts of water; then add as much chloride of zinc as the solution will take up.

Mix these solutions together in equal parts; use a zinc positive pole and one of Smee's compound batteries, intensity arrangement, charged with one part of sulphuric acid to twelve of water.

In from 45 minutes to an hour a deposit of the most beautiful lustre will be obtained, capable of yielding from 1,500 to 2,000 impressions, and even more, according to the experience of the manipulator.

I am, &c.,
HENRY BRADBURY.

Whitefriars, Feb. 3, 1859.

Proceedings of Institutions.

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CROYDON LITERARY AND SCIENTIFIC INSTITUTION.—In the report presented at the Annual Meeting held on Thursday, December the 9th, 1858, the Rev. J. G. Hodgson, M.A., President, in the chair, the Committee speak of the continued usefulness, as well as greater public appreciation of the Institution. The Members' List shews a considerable increase, whilst the account of income and expenditure shews an available balance. This is the second time only, in the history of the Institution, that such a financial position has been reached, and this in spite of the finances having been considerably tried by the outlay for furniture, fittings, and repairs incidental to the removal to a more commodious habitation. The total income from all sources (including a balance from last year of £46 1s. 11d.) amounted to £383 15s. 3d. the expenditure being £354 6s. 5½d., leaving a balance in favour of the Institution of £28 12s. 6½d. The average number of members was 505 against 438 of last year. During the past year 161 volumes have been added to the Library, half of them being purchased, bringing the number up to 4,663. The lectures which have been delivered during the past year have been of a varied and attractive character, and the attendance has been highly satisfactory. The following is a list of them:—Dr. G. Kinkel, "Early Christian and Byzantine Art;" Mr. G. Buckland, Musical Entertainment, "Songs of Dibdin and other Composers;" Mr. J. K. Applebee, on "Thomas Hood;" Mr. A. Francis, Dramatic Declamation from "Virginius;" Rev. C. Boutell, "National Flags of England;" Dr. Daniel, "Sir Walter Raleigh;" Dr. Daniel, "James Stuart the First;" Mr. D. W. King, Musical Entertaiment, "Up the Thames;" Mr. Geo. Grossmith, "Wit and Humour;" Mr. G. Barker, Musical Entertainment, "Moore's Melodies and Shakespere's Songs;" Dr. Daniel, "Charles Stuart the First;" Dr. Daniel, "Charles Stuart the Second;" Mr. J. E. Carpenter, Musical Entertainment; Dr. Daniel, "James Stuart the Second; Mr. B. Wells, "Lecture on the Flute;" Mrs. C. L. Balfour, "Charlotte Bronte;" Mr. H. Phillips, Entertainment, "Voyage through Life." The following were delivered gratuitously by gentlemen of the town and neighbourhood, to whom the Committee feel that a great debt of gratitude is owing, viz:—Col. Rowlandson, "The British Rule in India;" Rev. J. Steer, "George Stephenson;" Dr. Knighton, "Calcutta;" S. C. Hall, Esq., "Fairy Legends of Ireland;" Rev. G. Capel, "Numerical Notation;" J. H. Stocqueler, Esq., "Pleasures, Advantages, and Experiences of Foreign Travel;" D. Puseley, Esq., "Literary Entertainment;" Rev. W. Mitchell, "The Atlantic Telegraph;" Rev. J. White, "Science in a Drop of Water;" Rev. W. H. Johnstone, "The Materials and Construction of the Bible." The Committee are of opinion that these lectures have done more real service to the Institution than any received from paid lecturers, and they feel great satisfaction in stating that the list of gratuitous lecturers will be as extensive during the ensuing year. The Committee are promoting the establishment of a Company, under the Limited Liability Act, for the purpose of erecting a suitable Hall, and they state that a large number of shares have already been suscribed for. A list of donations for the same object has also been opened, and a considerable sum received. The formation of classes has not yet been fully carried out, but it is satisfactory to find that two have sprung into existence, viz., first, an Elocution and Discussion Class, which meets weekly, under the management of Mr. C. Messent, and, by urging the young men members to a careful reading of the subject to be discussed, is working some good; and second, a Music Class, held at the Town Hall, under the superintendence of Mr. J. T. Budd. The Committee wish to form classes for any subject that the members may require of an educational character, provided they are able to obtain proper superintendence.

MEETINGS FOR THE ENSUING WEEK.

MON. ......Royal Inst., 2. General Monthly Meeting.
London Inst., 7. Prof. Huxley, "On Biology."
Entomological, 8.
British Architects, 8. Mr. F. C. Penrose, "On Various Matters connected with St. Paul's Cathedral."
Medical, 8.

TUES. ......Royal Inst. 3. Professor Owen, "On Fossil Mammals."
Syro-Egyptian, 7½. Rev. B. H. Cowper, "On the Syrian Language and Literature."
Civil Engineers, 8. Mr. James W. Jameson, "On the Performances of the screw steam-ship *Sahel*, fitted up with Du Tremblay's combined vapour engine, and of the sister ship *Oasis*, with steam engines worked expansively, and provided with partial surface condensation."
Medical and Chirurg., 8½.
Zoological, 9.

WED. ......Literary Fund, 3.
London Inst., 3. Mr. E. W. Brayley, "On Meteorology."
Society of Arts, 8. Mr. P. L. Simmonds, "On the Utilisation of Waste Substances."
Graphic, 8.
Archæological Assoc., 8½.

THURS. ...Royal Inst., 3. Prof. Tyndall, "On the Force of Gravity."
Royal Soc. Club, 6.
London Inst., 7. Mr. G. MacDonald, "On the Poetry of the 16th Century."
Antiquaries, 8.
Philological, 8.
Royal, 8½.

FRI.........United Service Inst., 3. Mr. W. H. Flower, "On the importance of a knowledge of the Elements of Practical Surgery to Naval and Military Officers."
Astronomical, 8.
Royal Inst., 8½. Mr. E. Beckett Denison, "On some of the Grounds of Dissatisfaction with Modern Gothic Architecture."

SAT. ......Royal Inst., 3. Dr. W. A. Miller, "On Organic Chemistry."
London Inst., 3. Mr. Thomas A. Malone, "On the Metallic Elements, and their Principal Salts and Alloys."
Royal Botanic, 3¾.

PATENT LAW AMENDMENT ACT.

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APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, January* 28, 1859.]

Dated 10*th December*, 1858.

2832. J. Bethell, 8, Parliament-street—Imp. in machinery and apparatus for the preservation and colouring of wood.

Dated 31*st December*, 1858.

3004. J. H. Sievers, 48, Rathbone-place, Oxford-street—Apparatus for tightening and releasing the belly bands of riding saddles. (A com.)

Dated 3*rd January*, 1859.

28. E. Balchin, Myton-gate, Hull—An improved construction of projectile, applicable to the whale fishery.

Dated 7*th January*, 1859.

52. I. Holden, St. Denis, near Paris, and A. Holden, Bradford, Yorkshire—Imp. in means or apparatus employed in preparing and combing wool and other fibres.

54. J. J. Florance, Paris—Imp. in reels or spooling-wheels.
56. A. Barclay, Kilmarnock, N.B.—Imp. in electric and magnetic telegraphs.
58. H. Reynolds, Denmark-hill, Surrey—Imp. in refining and decolorizing saccharine substances.

Dated 8*th January*, 1859.

60. H. Harden, Dundalk, Ireland—Imp. in fire bars for steam boiler and other furnaces.
62. D. Friedlander, Manchester—An improved smoking pipe.
64. F. Versmann and A. Oppenheim, Bury-court, St. Mary Axe—Imp. in the treatment of various substances, by which to render the same uninflammable.

Dated 10*th January*, 1859.

72. R. D. Clegg, Manchester—Imp. in signalling apparatus.
74. T. J. Claxton, Montreal, Canada—Imp. in the manufacture of boots and shoes. (A com.)
76. J. S. Margetson, Cheapside—An improved box or case, suitable for hats, collars, and other useful purposes.

Dated 11*th January*, 1859.

80. C. M. Kernot, Gloucester-house, West Cowes, Isle of Wight—Imp. in purifying and decolorising paraffine, and rendering the same white, hard, and sweet.
82. B. Robbin, Yarmouth, Nova Scotia—Imp. in the machinery for working pumps.
84. D. E. Hughes, Northampton-square—An improved mode of insulating electrical conducting wires.
86. R. Hawthorn and W. Hawthorn, Newcastle-upon-Tyne—Imp. in apparatus for promoting combustion and preventing smoke in coal-burning locomotives and other steam-boiler furnaces.
88. F. Versmann and A. Oppenheim, Bury-court, St. Mary Axe—Imp. in rendering fabrics and substances non-inflammable.

Dated 12*th January*, 1859.

90. P. Bouché, 57, Rue de Bretagne, Paris—Imp. in the used means for mechanically raising up the gowns of ladies and young ladies.
91. W. Bray and W. T. G. Bray, Folkestone—Imp. in locomotive and traction engines.
92. W. Oliver, Shadwell—Imp. in boats, and in the mode of propelling them.
93. J. Thomson, Dundee—Imp. in the manufacture of rugs.
94. J. Hands, Elgin-crescent, Notting-hill—Imp. in preserving or preparing skins intended to be converted into leather, or otherwise manufactured.
95. J. Gibbons, 345, Oxford-street—Imp. in fixing door and other knobs.
96. S. Canning and H. Clifford, Leadenhall-street—Imp. in machinery for paying out and for recovering or picking up submarine telegraph ropes, cables, or chains.
97. T. Elwell, Paris—Imp. in governors for steam engines and other motive power engines.
98. W. McNaught, Manchester, and W. McNaught, Rochdale—Imp. in steam engines and in apparatus connected therewith.
99. S. Phillips, Moseley, Worcestershire—Imp. in fastenings for securing windows, shutters, and doors, and for other similar uses.
100. R. Mushet, Coleford, Gloucestershire—A new or improved metallic alloy.
101. R. Mushet, Coleford, Gloucestershire—An imp. or imps. in the manufacture of cast steel.
102. C. N. May, Devizes, Wiltshire—Imp. in sluice valves.
103. C. Beslay, 52, Rue St. Sebastien, Paris—Imp. in coating or covering iron or steel with tin, zinc, or lead, or alloys of those metals, by electrical deposit.

Dated 13*th January*, 1859.

104. C. N. May, Devizes, Wiltshire—An improved heat indicator.
105. R. A. Lightoller, Chorley, Lancashire—Certain imp. in machinery or apparatus for spinning cotton or other fibrous materials.
107. W. H. Crispin, Marsh-gate-lane, Stratford—Imp. in the construction of ships and other sailing and steam vessels.
108. H. Critchley and S. Elston, Bury, Lancashire—Certain imp. in pistons for steam engines or other purposes.
109. G. Scopes, Needham Market, Suffolk—Imp. in apparatus for communicating motion to cots, cradles, and other articles for children's use.
110. J. Picksley and R. Sims, Bedford Foundry, Leigh, Lancashire—Imp. in lawn mowing machines.
111. W. H. Morrison, Nottingham—Imp. in wind musical instruments.
112. D. L. Banks, Kennington, Surrey—A method of constructing a travelling suspension rail or roadway, applicable, among other uses, as a bridge and lifting agent.
113. J. J. Stevens, Darlington Works, Southwark—Imp. in railway signal apparatuses.
114. F. J. Manceau and E. N. Vieillard, Paris—Imp. in breech-loading fire-arms and in cartridges.
115. J. Grist, Beazley-crescent, Old Ford, Middlesex—Imp. in machinery for cutting and shaping staves and heads for casks, and for the manufacture of casks.
116. W. A. Chadwick, Wandsworth-road—A musical instrument, chiefly for teaching the intervals of musical scales.
118. T. Herbert and E. Whitaker, Nottingham—Imp. in the manufacture of warp lace.
119. O. Rowland, 4, Chapel-street West, May-fair—Imp. in laying electric telegraph wires in streets.
120. J. Barrans, 2, Caledonian-terrace, Queen's-road, Peckham—Imp. in traction and portable steam engines.
121. T. Sampson, Calle Cartanos, 8, Barcelona, Spain—Imp. in apparatus for feeding steam boilers with water.

Dated 14*th January*, 1859.

122. S. Holt, Manchester—A new and improved manufacture of woven silk fabrics.
124. William Craft, 12, Cambridge-road, Hammersmith, and T. Wilson, Bradmore-house, Chiswick—Imp. in drawers and napkins so as to render the same waterproof.
125. W. Davis, 2, Ann-street, Globe-fields, Mile-end—Imp. in sluice valves.
126. J. Dauglish, M.D., Tunbridge Wells—Imp. in obtaining carbonic acid gas.
127. R. Romaine, Chapel-street, Bedford-row—An improved arrangement of portable railway.

Dated 15*th January*, 1859.

129. W. H. E. McKnight, Lydiard-house, near Swindon, Wiltshire—An upright-celled boiler applicable to all heating purposes by hot water or other fluid.
131. D. L. Banks, 3, Kennington-row, Kennington-park—Imp. in the method of constructing a travelling suspension rail or roadway, to be used for the cultivation of land.
133. W. Betts, Wharf-road, City-road—Imp. in the manufacture of capsules, and in the apparatus employed therein.

Dated 17*th January*, 1859.

135. W. Morgan, 31, Grafton-street, Fitzroy-square—Imp. in printing and stencilling, and in the apparatus or machinery used therein, also for certain applications of such printing and stencilling.
137. J. Montgomery, New York, U.S.—Imp. in the construction of the hulls of steam and other vessels, and in the feed-water heaters, boilers, water-gauges, condensers, engines, and propelling machinery appertaining to the former, a portion of which improvements, with the exception of those on the hull, are applicable to analogous useful purposes.
139. P. A. de S. S. Sicard, Paris—An improved process and apparatus for converting cast iron into steel.
141. W. E. Newton, 65, Chancery-lane—An imp. in sewing machines. (A com.)
143. R. G. Salter, Alphington, Devonshire—Imp. in apparatuses for collecting or picking up letters, papers, and other articles requiring to be stamped or printed.
145. R. Mushet, Coleford, Gloucestershire—Imp. in the manufacture of cast steel.

WEEKLY LIST OF PATENTS SEALED.

[*From Gazette*, *Jan.* 28, 1859.]

January 28*th.*
1714. J. Brierley.
1716. J. F. W. Featherstonhaugh and F. Wise.
1722. J. Watkins.
1723. C. Schiele and F. Schiele.
1725. T. Webb and J. Craig.
1726. J. Davey, H. Sims, J. Mayne, W. Hodge, and J. Gerrans.
1729. J. S. Bailey.
1733. G. Ashcroft and H. W. Wood.
1734. G. Davies.
1736. H. Conybeare.
1737. H. Conybeare.
1750. J. L. Norton.
1758. R. Cunningham.
1760. G. Bell.
1763. J. Greenwood.
1768. J. Taylor.
1776. J. Luis.
1859. A. Slate.
1946. W. E. Newton.
1950. Jonathan Ireland.
1978. A. V. Newton.
2046. J. Wright, sen., and J. Wright, jun.
2156. C. Hall.
2310. T. W. G. Treeby.
2317. B. Nickels.
2399. J. W. Mott.
2452. H. Tertian-Moret.
2498. W. Smith.
2606. J. M. Miller and J. Fear.
2652. E. H. Bentall.
2660. A. V. Newton.
2698. R. Alexander.
2721. J. Gresham.
2754. L. Mac Kirdy.
2755. L. Mac Kirdy.
2767. C. Coates.

[*From Gazette*, *Feb.* 1, 1859.]

February 1*st.*
1744. J. W. Schlesinger.
1747. S. Hine.
1766. C. Callebaut.
1779. J. Luis.
1785. R. A. Brooman.
1794. S. Carey.
1795. G. Weston.
1820. R. H. Collyer, M.D.
1837. J. Fogg.
1893. F. Preston & W. McGregor.
1924. J. Macintosh.
2037. A. McEwan Peters.
2373. W. E. Newton.
2416. W. E. Newton.
2651. A. V. Newton.
2775. R. Pickering.
2821. H. Maudslay.

Patents on which the Stamp Duty of £50 has been paid.

[*From Gazette*, *January* 28, 1859.]

January 24*th.*
222. J. Wormald.
254. J. L. Stevens.
January 25*th.*
236. D. Foxwell.
January 26*th.*
269. T. Hurst.

[*From Gazette*, *Feb.* 1, 1858.]

January 27*th.*
299. E. S. Robinson.
January 28*th.*
255. J. Gretton.
261. H. Tylor.
268. J. B. Anderson.
287. B. F. Miller.
318. J. Howard.